



Scrap Tire Workshop

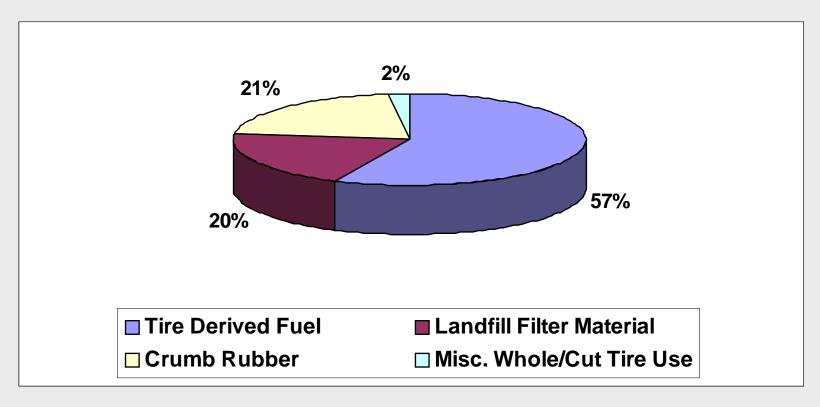
Engineering Applications for Landfills

June 22, 2005

SECTION 1: Introduction

- □ This training proposal is designed to assist engineers, planners, landfill operators, and landfill managers, learn about specific engineering properties and applications for processed tires in landfills.
- □ Each registrant will receive a proof of completion form in the mail that may be used to request continuing education contact hours towards their Certified Landfill Operator certificate renewal.

End Uses of Processed Tires in Iowa



Source: Iowa DNR

Section 1: Introduction – Page 1

Definition: Civil Engineering Application

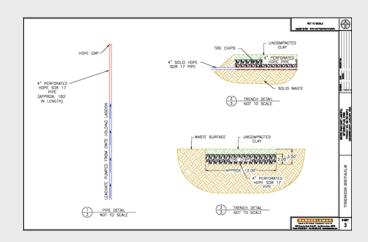
□ To be a considered a civil engineering application (and not a disposal application) a project should reuse waste tires, either whole or processed, in place of naturally occurring materials in construction (i.e. sand, gravel, clay), in a manner that provides a defined engineering benefit.

Characteristics of tire derived aggregates (TDA) commonly utilized in engineered landfill projects:

- Lightweight;
- Durable;
- Compressible;
- Good insulators, and:
- Good hydraulic conductivity.

ASTM Standard D 6270:

"It is the responsibility of the design engineer to determine the appropriateness of using scrap tires in any particular application and to select applicable tests and specifications to facilitate construction and environmental protection." (4)



Section 1: Introduction: Page 4

Definition: Tire Derived Aggregate (TDA)

□ Pieces of processed tires that have a consistent shape and are generally between 25mm (1 in.) and 300mm (12 in.) in size.



Typical Example of TDA

Section 1: Introduction: Page 5

SECTION 2:

ASTM International Standards

Pages 7-10



Class I Fills:

(TDA placed in layers less than 1m (~3') thick.)

- □ Have a maximum of 50% (by weight) passing the 38 mm (~1.5") sieve.
- □ Have a maximum of 5% (by weight) passing the 4.75 mm (~.19") sieve.

No special design features required to reduce heating situations.

Class I Fills are typically utilized in landfill leachate and gas control applications.

Section 2: ASTM Material Characterization for Tires – Page 8

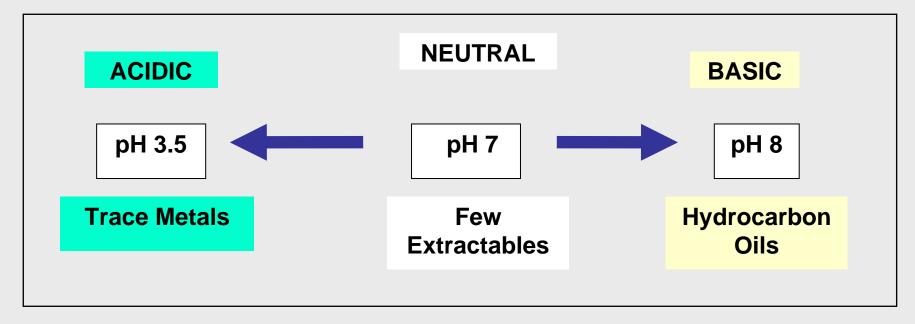
Class II Fills:

(TDA placed in layers ranging from 1m (~3') to 3m (~10') thick.)

- □ Have a maximum of 25% (by weight) passing the 38 mm (1.5") sieve.
- □ Have a maximum of 1% (by weight) passing the 4.75 mm (~.19") sieve.

Leaching from Tires





Section 2: ASTM Material Characterization for Tires – Page 9

Water Table Considerations

At this time, ASTM <u>does not</u> recommend the use of tire derived aggregates <u>below the</u> <u>water table</u>.

Section 2: ASTM Material Characterization for Tires – Page 9

SECTION 3:

General Physical Characteristics of Tire Derived Aggregate (TDA)

Pages 11-24

Definition: Compacted Dry Density

A measure of the compactive effort required to achieve a workable material density.

The compacted dry density of TDA makes it an attractive light weight fill for embankment construction on weak compressible soils where slope stability or excessive settlement is a concern.

Section 3: General Physical Characteristics of TDA – Page 11

Compacted Dry Density cont...

- □ The average compacted density of TDA ranges from 40 lb/ft³ to 52 lb/ft³.
 - \blacksquare (1/3 to 1/2 that of typical soil). (4) (5) (6)
 - Typically achieved through 4-8 passes from a sheepsfoot, landfill compactor, tracked bulldozer, smooth drum roller, or equivalent equipment.
- □ Typical dry densities of 3" to 4" nominal TDA in Iowa have been reported to be between 24 lb/ft³ and 28 lb/ft³. (24)

Definition: Thermal Conductivity

- □ Relates to the ability of a material to conduct heat.
- □ The thermal conductivity of TDA makes it a good option for applications where insulation value is important. (i.e. Protecting roads from freeze/thaw cycles).

Section 3: General Physical Characteristics of TDA – Page 11

Definition: Hydraulic Conductivity

- □ The rate of water flow under laminar flow conditions through a unit cross-sectional area of porous medium under unity hydraulic gradient and standard temperature conditions.
 - Of primary importance when assessing the feasibility of using TDA as a drainage material.

Section 3: General Physical Characteristics of TDA – Pages 11-14

Definition: Specific Gravity

- The ratio of the unit weight of solids divided by the unit weight of water. A material, whose unit weight of solids equals the unit weight of water, has a specific gravity of 1.0.
- □ TDA Specific Gravity generally ranges from 1.02 to 1.27 depending on the amount of steel wire in the tire. (2)
 - □ ½ the value for common earthen coarse aggregate

Definition: Compressibility

- □ The susceptibility of a material to volume change due to changes in stress.
- □ Due to its porosity and high rubber content, TDA is highly compressible under loaded conditions. Under high normal loads, TDA can compress by as much as 50%.

Section 3: General Physical Characteristics of TDA – Pages 16-18

Definition: Shear Strength

- □ The shear strength between two particles is the force that must be applied to cause a relative movement between the particles.
- □ Shear strength is a fundamental mechanical property that governs bearing capacity and slope stability.

Section 3: General Physical Characteristics of TDA – Pages 19-21

Definition: Water Absorption

□ The amount of water absorbed onto the surface of a particle and is expressed as the percentage (%) of water by weight.

□ Water absorption capacity for TDA generally ranges from 2% to 4%. (2)

Section 3: General Physical Characteristics of TDA – Page 21

Definition: Combustibility

- The potential of a material to react vigorously with oxygen to produce heat and light.
 - Both TDA and whole tires have a flash point of approximately 580° F (3).

Under the right conditions, TDA has the potential to create an internal heating reaction that could lead to a fire.

Section 3: General Physical Characteristics of TDA – Page 21-23

Combustibility cont...

Research has shown that historical, self-ignited TDA fill fires were associated with projects where TDA was at least 6m (~20 feet) in compacted thickness.

ASTM D6270 advises that tire derived aggregate projects not be greater than 3m (10') in thickness.

Section 3: General Physical Characteristics of TDA – Page 22

SECTION 4:

General Physical Characteristics of Tire Derived Aggregate (TDA)

Pages 25-30

Compatibility with Geosynthetics and Liners

Exposed wire from TDA presents a significant puncture hazard for any geosynthetic layer that may be used in a civil engineering project.

□ Tire Derived Aggregate Quality Concerns

- 1. TDA should be kept as clean as possible before installation.
- 2. TDA should not contain dirt clods, loose wires, or be coated with fines.
- 3. TDA should be free from excess oil, grease, gasoline, diesel fuel, etc, that could create a fire hazard.

Section 4: Other Issues

□ Tire Derived Aggregate Quality Concerns

- 4. TDA should be free from wood debris and fibrous organic matter.
- 5. TDA should not contain material derived from tires that were previously subjected to fire as the heat may have liberated petroleum products that could create a fire hazard.

SECTION 5:

Engineered Landfill Applications for Scrap Tires

Pages 31-64

Federal Requirements - Leachate Collection Layer

The Code of Federal Requirements (Title 40, Part 258) requires MSW landfills to install a leachate drainage layer:

"New MSWLF units and lateral expansions shall be constructed".....(2) With a composite liner... and a leachate collection system that is designed and constructed to maintain less than a 30-cm depth of leachate over the liner."

Section 5: Engineered Applications for Scrap Tires – Page 31

<u>Iowa Permitting Requirements</u> - <u>Leachate Collection Layer</u>

- Any leachate collection system design incorporating TDA must be approved by engineering staff at the Iowa Department of Natural Resources.
- □ Iowa Administrative Code IAC 567-117.8(6)f states that the following application is considered an acceptable beneficial use for shredded waste tires:
 - "Landfill drainage medium at a permitted municipal landfill, provided that the medium meets engineering and design requirements for the landfill's operating permit, pursuant to 567 Chapter 102."

□ Tire Derived Aggregate (TDA) Needs

Leachate Collection Layer

■ While utilization of whole tires has been approved in prior Iowa leachate collection layer projects, the Iowa DNR has expressed a current preference for landfill leachate projects utilizing 3" to 4" nominal TDA – unless engineering documentation is provided to substantiate a viable alternative design. (23)

■ Logistics and Compaction

Spreading and placement is normally conducted with a track mounted dozer, loader, or steel wheeled compactor with a blade.

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Section 5: Engineered Applications for Scrap Tires - Leachate Collection Layer

□ Compaction - Leachate Collection Layer

- TDA may be compacted with a sheepsfoot, landfill compactor, tracked bulldozer, smooth drum roller, or equivalent equipment. Generally 4 to 6 passes are required. (11)
- Sheepsfoot rollers and compactors tend to "fluff" the surface of a layer of TDA and should generally not be used for compacting the last lift of TDA. (11)

Leachate Collection System Pipe Bedding Concerns

- Ohio EPA does not recommend placement of TDA as leachate collection pipe bedding due to the compressible nature of TDA and the risk of the pipe crushing or deflecting under the weight of the overlying waste. (7)
- A report prepared by Robert Phaneuf, P.E. for the New York State Department of Environmental Conservation suggests that thought be given to the use of conventional soil drainage media bedding around leachate collection pipes. (3)

Leachate Collection Layer Case Study

Blackhawk County Sanitary Landfill, Waterloo, IA

Speaker: Gary Wilcox

Leachate Collection Layer Case Study

Metro Park East Landfill, Mitchellville, IA

Leachate Recirculation Trench

- Installed in 2003.
- Used for as-needed recirculation of leachate back into the facility's fill area when head levels in the leachate storage lagoon elevate during the winter months.



Metro Park East Landfill Leachate Storage Lagoon

Section 5: Engineered Applications for Scrap Tires – Pages 38-39

Metro Park East Landfill, Mitchellville, IA

Leachate Recirculation Trench

- ~600' of solid HDPE SDR 17 pipe installed for transfer of leachate from the lagoon to the recirculation trench.
- 106' of 4" perforated HDPE SDR 17 pipe installed in the leachate recirculation trench.
- 4" perforated pipe was bedded in 2 feet of 3" to 4" nominal size TDA and backfilled with uncompacted clay.
- As needed, leachate is pumped from the CWTS holding lagoon and injected into the leachate recirculation trench.
- A valve was installed at a manhole location to allow fluid to drain from the pipe following pumping activities.

Leachate Collection Layer Case Study

Audubon County Sanitary Landfill, Audubon, IA

Leachate Recirculation Trench

- Installed in 2002
- TDA was utilized to backfill trenches excavated within the existing waste boundary of the facility for the purpose of leachate collection and extraction.

Leachate Recirculation Trench

- ~340' of 4" HDPE SDR 17 perforated pipe trenched in the targeted fill area and backfilled with 3' to 5' of 3" to 4" nominal size TDA.
- The pipe was connected to approximately 890' of 2" HDPE SDR 17 solid pipe that transports the pumped leachate from an existing leachate lagoon on the site property.
- The trenches within the waste boundary were capped with the excavated waste and soils and covered as per normal operating procedures.

Leachate Collection Layer Case Study

Audubon County Sanitary Landfill, Audubon, IA

Leachate Recirculation Trench

- Following backfilling, a ½ horsepower pump, with pumping capabilities of 25 gallons per minute, was installed with valve and check valves for maintenance and back flow prevention purposes.
- A pump control was also installed to avoid pump damage in the event that the lagoon is pumped dry.

Leachate Recirculation Trench



Barker Lemar staff performing GPS Surveying.

Section 5: Engineered Applications for Scrap Tires – Pages 40-41

Leachate Recirculation Trench



Excavating the Leachate Recirculation System piping trench.

Section 5: Engineered Applications for Scrap Tires – Pages 40-41

Leachate Recirculation Trench



Approximately 650' of excavated trench containing 2" HDPE SDR 11 solid pipe.

Leachate Collection Layer Case Study

Leachate Recirculation Trench



TDA used as backfill at Audubon County Sanitary Landfill leachate recirculation project.

Section 5: Engineered Applications for Scrap Tires – Pages 40-41

Leachate Collection Layer Case Study

Des Moines County Regional Sanitary Landfill, Burlington IA

Leachate Toe Drain

- Installed in 2001
- This structure utilized TDA as drainage media to collect leachate from the toe.

Des Moines County Regional Sanitary Landfill, Burlington IA

Leachate Toe Drain

- A trench was excavated at the bottom of the target waste boundary and a 4" HDPE SDR 17 perforated pipe was placed at the trench base.
- The perforated pipe was fused to an existing 6" HDPE header pipe and connected to the facility's leachate collection system.
- A 4" gate valve was installed in event the flow must be stopped for maintenance purposes.
- The trench was backfilled with 1,004 tons of 4" to 6" nominal sized TDA.
- 24" of uncompacted soil was placed above the TDA for vegetative growth.
- A 6 oz nonwoven geotextile liner was installed between the uncompacted soil and the TDA.

Des Moines County Regional Sanitary Landfill, Burlington IA Leachate Toe Drain



Des Moines County
Regional Sanitary
Landfill Toe Drain
Trench containing 4''
HDPE perforated pipe
covered with tire chips.

Section 5: Engineered Applications for Scrap Tires – Pages 40-41

Des Moines County Regional Sanitary Landfill, Burlington IA Leachate Toe Drain



Des Moines County
Regional Sanitary
Landfill Toe Drain
Trench is covered with
Filter Fabric Prior to
Backfilling.

Section 5: Engineered Applications for Scrap Tires – Pages 40-41

Leachate Collection Layer Case Study

Michigan State University Study

Leachate Recirculation Blanket

This study utilized a "<u>permeable blanket</u>" consisting of TDA to evaluate the efficiency of the system for subsurface recirculation of leachate back into a landfill.



Michigan State University Study

Leachate Recirculation Blanket

Michigan State Study Design Considerations:

- A non woven geotextile was laid horizontally on the existing MSW surface (test area was 180' x 30').
- Approximately .6m (2') of TDA (unspecified size) was placed on the geotextile.
- A perforated HDPE pipe was installed at the center of the test section, parallel to the short side, for injecting leachate.
- A non-woven geotextile was placed over the TDA layer.
- The upper geotextile was covered by MSW.

Michigan State University Study

Leachate Recirculation Blanket

Michigan State Study Conclusion:

Research indicated efficient hydraulic recirculation across the entire blanket area.

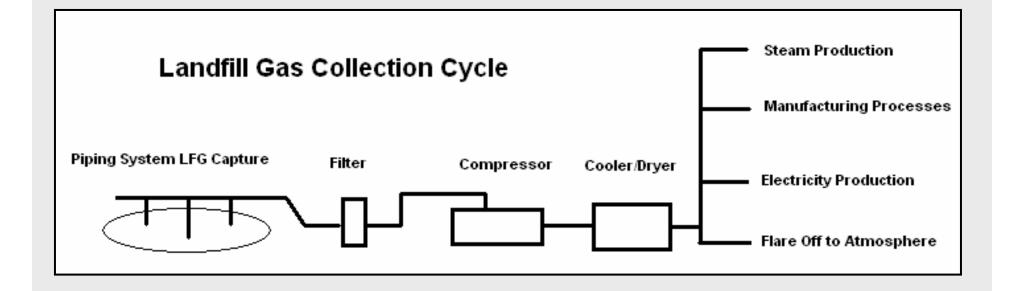
Potential Benefits of Using a Recirculation Blanket:

- Reduction in leachate treatment and disposal costs.
- More uniform distribution of leachate.
- More uniform settlement across waste areas.

Definition: Gas Collection Layer

- An engineered landfill layer that provides gas collection and venting to control discharge of landfill gas under active or passive extraction.
- This layer is typically located directly beneath the infiltration layer in the closure cap.

Landfill gas may be used for steam or electric production, manufacturing processes, or simply flared off to the atmosphere.



Section 5: Engineered Applications for Scrap Tires – Page 40

Federal Requirements:

- Requirements for management of fugitive gases from landfills are found in 40 CFR Part 60.
- Threshold values above which regulation applies under this part are found in 40 CFR Part 60 § 60.752:

2.5 million cubic meters

or

2.5 million mega grams

Iowa Permitting Requirements:

 Gas collection system designs incorporating TDA must be approved by IDNR engineering staff.

TDA NEEDS:

- □ Approximately 1,667 yd³ (1,250 m³) of TDA is required to produce a 12 inch (300-mm) thick landfill gas collection layer over a one (1) acre area. (12)
- □ A typical landfill gas collection layer is 6 to 12 inches thick. (12)
- \square 1 yd³ of TDA = 60 to 70 whole passenger tires (12)

Tire Derived Aggregate (TDA) Size, cont...

Utilize ASTM 6270 as Basic Guideline

□ A report by GeoSyntec Consultants, Inc. for the California Integrated Waste Management Board suggests that TDA used for gas collection should have a maximum dimension, measured in any direction, of 12-in. and conform to the this schedule:

SIEVE SIZE* IN. (MM)	MINIMUM PASSING (% BY WEIGHT)
12 (300)	100
6 (150)	95 50
3 (75)	50
#4 (4.75)	5

^{*}Indicates square mesh sieve

Section 5: Engineered Applications for Scrap Tires – Pages 47-48

Definition: Landfill Gas Control Trench

Typically located outside the landfill footprint and used to reduce lateral migration and to control discharge of landfill gas under active or passive extraction.



Section 5: Engineered Applications for Scrap Tires – Page 51

□ Federal Requirements

- The Code of Federal Requirements (Title 40, Part 258) requires MSW landfills to ensure that the concentration of methane gas does not exceed the lower explosive limit for methane at the facility property boundary.
- In cases were landfill gas may be migrating underground from a fill area and mitigation is necessary, a gas collection trench utilizing TDA may be a beneficial solution.

□ Iowa Permitting Requirements

Any landfill gas control trench system design incorporating TDA must be approved by IDNR engineering staff.

- □ ASTM D6270 does not recommend the use of TDA below the water table.
 - ☐ If the landfill gas trench application will be excavated below the water table, it is recommended that the Project Engineer consider possible leaching outcomes.

Definition: Landfill Operations Layer

Separates waste from and provides protection to the underlying landfill containment system.

Typically located between a landfill's initial lift of waste and the leachate collection layer.

Landfill Road Base

- □ TDA has been used with mixed results as subbase material in roads and other paving applications.
- In some areas of the country, TDA has been successfully utilized in wet or boggy areas and in areas with high soil compressibility to help "float" the road surface.

Iowa Permitting Requirements

Any landfill road base system design incorporating TDA must be approved by engineering staff at the Iowa Department of Natural Resources.

Section 5: Engineered Applications for Scrap Tires – Landfill Road Base

Tire Derived Aggregate (TDA) Needs

- □ Should be determined based on specific engineering applications.
- □ ASTM D6270 advises that tire derived aggregate projects not be greater than 3m (10') in thickness.

Section 5: Engineered Applications for Scrap Tires – Landfill Road Base

TDA Layer Placement

■ ASTM Standard D6270-98 mentions that TDA used under areas that are paved should be covered with a sufficient thickness of soil to limit deflections of overlying pavement from traffic loading.

Light Duty Use Paved Roads	May need as little as .8m (~2.5") of soil cover.
Heavy Duty Use Paved Roads	May need 1m (3') to 2m (6') of soil cover (4)

Section 5: Engineered Applications for Scrap Tires – Landfill Road Base

Tracy Lemar

Keys to Successful Tire Projects

Keys to Successful Tire Projects

- □ Planning, Planning
- Make sure tires are compatible with your design and other materials
- □ Supply is adequate for the anticipated usage
- □ Take advantage of the intrinsic properties of the tires
- Evaluate the impact that tires may have when in contact with water or leachate

Compatibility

- □ Compatible with the surrounding materials (i.e., liners, etc.)
- □ Incorrect placement can cause hazards (i.e., combustion)
- □ Worker safety during placement
- Proper equipment and realistic placement requirements

Supply

- □ Availability
 - Product
 - Quantity
 - Quality
 - Staging/storage requirements

Take Advantage of Tire Properties

- □ Higher Hydraulic Conductivity
 - Less thickness needed to obtain similar transmissivity
- □ Insulating Properties
 - May be secondary benefit when using as a drainage layer or in piping trenches

Impact to Water/Leachate Quality

- □ Leaching will be controlled by pH of fluid
 - Low level organic contamination may result at pH levels above 8
- □ Manganese, Zinc and Iron may leach
 - May be a concern with leachate treatment agreements or stormwater discharge permits

Specifications

A discussion of customizing specifications for your individual project.

SECTION 6:

State and Local Approval Process

Pages 65-72

State Approval Processes

State of Iowa Code - IAC 567-117.8(1)

"....The Department shall have the authority to determine if a proposed use of waste tires is beneficial and shall have the authority to approve or deny applications if such a benefit is not evident."

Section 6: State Approval Processes – Page 65

Approved End Uses of Whole Tires

□ Culvert piping made from waste tire with a rim diameter of 21 inches or greater.

□ NOT APPROVED:

Fences, windbreaks, barricades,



Appendix C:

Sources of Tire Derived Aggregate

Sources of Tire Derived Aggregate

- □ Processor pricing strategies can vary by facility and season and can be dependant on multiple variables:
 - Specification requirements for TDA.
 - □ (Smaller sizes generally require more time/labor to produce)
 - □ (TDA with less exposed wire is generally more expensive)
 - Quantity of TDA being purchased.
 - Distance from processing facility to project site.
 - Demand from other market outlets.

□ TDA Specifications

- TDA is generally lighter in weight than traditional aggregates (sand, gravel) and a ton of TDA will generally cover a larger area.
- The average compacted density of TDA ranges from 40 lb/ft3 to 50 lb/ft3 and is 1/3 to 1/2 that of typical soils. (5)
- Typical dry densities of 3" to 4" nominal TDA in Iowa have been reported to be between 24 lb/ft3 and 28 lb/ft3. (24)

Speaker: Chuck Grob GreenMan Technologies Des Moines, IA

Sources of Tire Derived Aggregate - Appendix C

- TDA has a typical non-compacted dry density between 24 and 28 lbs/square foot
- TDA has a non-compacted dry volume that is 1/3 to ½ that of typical sand and gravel fills
- 1 ton of sand = \sim .74 cubic yards
- 1 ton of TDA = \sim 2.8 cubic yards
- A 12 ft. landfill gas collection layer could require:
 - \Box 2,181 tons of sand or
 - □ 577 tons of TDA

Appendix B:

Sample Specifications for Landfill Engineering Applications

Sample Specifications

□ Sample specifications have been included in Appendix B.

Specifications utilize an outline modeled after Statewide Urban Standard Designs and Specifications.

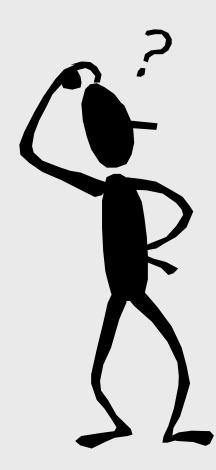
Summary

- □ **ASTM D6270**
- □ Lightweight;
- □ Durable;
- Compressible;
- □ Good insulators, and:
- □ Good hydraulic conductivity

Summary

□ Various states and private researchers have developed recommendations and standards

Questions??



Thank You For Attending!

FOR ADDITIONAL INFORMATION:

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